Claims

1. An apparatus to determine, within an acceptable time of setup of a wireless telephone call, a classification of a geographic point, comprising:

a computer system in turn comprising one or more mass storage subsystems, one or more main memory subsystems, one or more interconnected processors, and one or more connections to a telephone network;

a first database stored in one or more of the mass storage subsystems and containing a set of all classifications used, wherein each member of the set identifies a distinct classification of a geographical area and its geographical boundaries;

a second database stored in one or more of the main memory subsystems and containing all information from the first database necessary to determine the classification of a geographic point using the geographic point's coordinates;

a retrieval program, operating within one or more of the processors, whereby the geographic point's classification is found within the second database and retrieved for use.

2. The apparatus of claim 1 wherein the retrieval program further comprises:

a spatial index retrieval program;

a point-in-polygon determination program for deciding whether a given point falls within a given classification polygon;

a polygon-in-polygon determination program for deciding whether a given first polygon falls within a given second classification polygon, falls outside the second classification polygon, overlaps the second classification polygon, or shares a vertex or boundary with the second classification polygon;

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a program means for returning the identity of the determined classification for use.

3. The apparatus of claim 2 further comprising a first conversion program, operating within one or more of the processors, whereby the geographic point's latitude and longitude are converted to coordinates uniquely locating the geographic point in a coordinate system used in the second database.

4. The apparatus of claim 3 further comprising a second conversion program, operating within one or more of the processors, whereby the geographic point's latitude, longitude, and elevation are converted to coordinates uniquely locating the geographic point in a coordinate system used in the second database.

5. The apparatus of claim 4 wherein each classification comprises geocoded data.

6. The apparatus of claim 5 wherein each classification comprises one of a set of Public Safety Answering Points (PSAPs).

7. The apparatus of claim 5 wherein each classification comprises one of a set of telephone company rate zones.

8. The apparatus of claim 5 wherein each classification comprises one of a set of wireless communication service areas.

9. The apparatus of claim 5 wherein each classification comprises one of a set of commercial franchise areas.

10. The apparatus of claim 5 wherein each classification comprises one of a set of commercial service zones.

11. The apparatus of claim 5 wherein each classification comprises a service area classification.

12. The apparatus of claim 5 wherein the second database further comprises:

a spatial index of recursively nested geographical regions;

a base table associating each region with one or more classifications.

13. The apparatus of claim 12 wherein the base table of the second database comprises the leaf nodes of the spatial index.

14. The apparatus of claim 12 wherein the spatial index of the second database comprises an R-tree index.

15. The apparatus of claim 12 wherein the spatial index of the second database comprises an R*-tree (R-star tree) index.

16. The apparatus of claim 12 wherein the spatial index of the second database comprises an R+-tree (R-plus tree) index.

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17. The apparatus of claim 12 wherein the spatial index of the second database comprises a Hilbert R-tree index.

18. The apparatus of claim 12 wherein the spatial index of the second database

5 comprises an X-tree index.

19. The apparatus of claim 1 further comprising an interface program, operating within one or more of the processors, whereby the geographic point may be obtained from a requesting entity and the classification of that point returned to the requesting

10 entity.

20. The apparatus of claim 5 further comprising a loading program, operating within one or more of the processors, whereby the geographic boundary classification contents of the first database are loaded into the second database without interfering

15 substantially with the functioning or the speed of the retrieval program.

21. The apparatus of claim 20 wherein the loading program loads the geographic boundary classification contents of the first database into the second database in a more-compact form to save memory space.

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22. The apparatus of claim 1 wherein an acceptable time of setup of a wireless telephone call must be less than one second.

23. A location management platform apparatus to determine, within an acceptable time of setup of a wireless telephone call, a classification of a geographic point, comprising:

a computer system in turn comprising one or more mass storage subsystems, one or more main memory subsystems, one or more interconnected processors, and one or more connections to a telephone network;

a first database stored in one or more of the mass storage subsystems and containing a set of all classifications used, wherein each member of the set identifies a distinct classification of a geographical area and its geographical boundaries;

a second database stored in one or more of the main memory subsystems and containing all information from the first database necessary to determine the classification of a geographic point using the geographic point's coordinates;

a retrieval program, operating within one or more of the processors, whereby the geographic point's classification is found within the second database and retrieved for use.

24. The location management platform apparatus of claim 23 wherein the retrieval program further comprises:

a spatial index retrieval program;

a point-in-polygon determination program for deciding whether a given point falls within a given classification polygon;

a polygon-in-polygon determination program for deciding whether a given first polygon falls within a given second classification polygon, falls outside the second

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classification polygon, overlaps the second classification polygon, or shares a vertex

or boundary with the second classification polygon;

a program means for returning the identity of the determined classification for

use.

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25. The location management platform apparatus of claim 24 further comprising a

first conversion program, operating within one or more of the processors, whereby the

geographic point's latitude and longitude are converted to coordinates uniquely

locating the geographic point in a coordinate system used in the second database.

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26. The location management platform apparatus of claim 25 further comprising a

second conversion program, operating within one or more of the processors, whereby

the geographic point's latitude, longitude, and elevation are converted to coordinates

uniquely locating the geographic point in a coordinate system used in the second

15 database.

27. The location management platform apparatus of claim 26 wherein each

classification comprises geocoded data.

20 28. The location management platform apparatus of claim 27 wherein each

classification comprises one of a set of Public Safety Answering Points (PSAPs).

29. The location management platform apparatus of claim 27 wherein each

classification comprises one of a set of telephone company rate zones.

30. The location management platform apparatus of claim 27 wherein each classification comprises one of a set of wireless communication service areas.

31. The location management platform apparatus of claim 27 wherein each classification comprises one of a set of commercial franchise areas.

32. The location management platform apparatus of claim 27 wherein each classification comprises one of a set of commercial service zones.

33. The location management platform apparatus of claim 27 wherein each classification comprises a service area classification.

34. The location management platform apparatus of claim 27 wherein the second database further comprises a spatial index of recursively nested geographical regions and a base table associating each region with one or more classifications.

35. The location management platform apparatus of claim 34 wherein the base table of the second database comprises the leaf nodes of the spatial index.

36. The location management platform apparatus of claim 34 wherein the spatial index of the second database comprises an R-tree index.

37. The location management platform apparatus of claim 34 wherein the spatial index of the second database comprises an R*-tree (R-star tree) index.

38. The location management platform apparatus of claim 34 wherein the spatial index of the second database comprises an R+-tree (R-plus tree) index.

39. The location management platform apparatus of claim 34 wherein the spatial index of the second database comprises a Hilbert R-tree index.

40. The location management platform apparatus of claim 34 wherein the spatial index of the second database comprises an X-tree index.

41. The location management platform apparatus of claim 27 further comprising a loading program, operating within one or more of the processors, whereby the geographic boundary classification contents of the first database are loaded into the second database without interfering substantially with the functioning or the speed of the retrieval program.

42. The location management platform apparatus of claim 41 wherein the loading program loads the geographic boundary classification contents of the first database into the second database in a more-compact form to save memory space.

43. The location management platform apparatus of claim 23 wherein an acceptable time of setup of a wireless telephone call must be less than one second.

44. An apparatus to determine, within an acceptable caller waiting time during a wireless telephone call, a geographic point, comprising:

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a computer system in turn comprising one or more mass storage subsystems,

one or more main memory subsystems, one or more interconnected processors, and

one or more connections to a telephone network;

a first database stored in one or more of the mass storage subsystems and

5   containing the set of all classifications used, wherein each member of the set identifies

a distinct classification of a geographical area and its geographical boundaries;

a second database stored in one or more of the main memory subsystems and

containing all information from the first database necessary to determine the

classification of a geographic point using said point's coordinates;

10   a retrieval program, operating within one or more of the processors, whereby

the geographic point's location identifier may be estimated using known reference

points in the second database.

45. The apparatus of claim 44 wherein the retrieval program further comprises:

15   a spatial index retrieval program;

a point-in-polygon determination program for deciding whether a given point

falls within a given classification polygon;

a polygon-in-polygon determination program for deciding whether a given first

polygon falls within a given second classification polygon, falls outside the second

20   classification polygon, overlaps the second classification polygon, or shares a vertex

or boundary with the second classification polygon;

a program means for returning the identity of the determined classification for

use.

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46. The apparatus of claim 45 further comprising a first conversion program, operating within one or more of the processors, whereby the geographic point's latitude and longitude are converted to coordinates uniquely locating the geographic point in a coordinate system used in the second database,

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47. The apparatus of claim 46 further comprising a second conversion program, operating within one or more of the processors, whereby the geographic point's latitude, longitude, and elevation are converted to coordinates uniquely locating the geographic point in a coordinate system used in the second database.

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48. The apparatus of claim 47 wherein each classification comprises geocoded data.

49. The apparatus of claim 48 wherein the location identifier comprises a street address.

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50. The apparatus of claim 48 wherein the second database further comprises a spatial index of recursively nested geographical regions and a base table associating each region with one or more classifications.

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51. The apparatus of claim 50 wherein the base table of the second database comprises the leaf nodes of the spatial index.

52. The apparatus of claim 50 wherein the spatial index of the second database comprises an R-tree index.

53. The apparatus of claim 50 wherein the spatial index of the second database comprises an R*-tree (R-star tree) index.

54. The apparatus of claim 50 wherein the spatial index of the second database

5   comprises an R+-tree (R-plus tree) index.

55. The apparatus of claim 50 wherein the spatial index of the second database comprises a Hilbert R-tree index.

10   56. The apparatus of claim 50 wherein the spatial index of the second database comprises an X-tree index.

57. The apparatus of claim 44 further comprising an interface program, operating within one or more of the processors, whereby the geographic point may be obtained from a requesting entity and the location identifier of that point returned to the

15   requesting entity.

58. The apparatus of claim 48 further comprising a validation program, operating within one or more of the processors, whereby the estimated geographic location

20   identifier is validated by comparison to known geographic location identifiers in the second database.

59. The apparatus of claim 48 further comprising a loading program, operating within one or more of the processors, whereby the geographic boundary classification

contents of the first database are loaded into the second database without interfering

substantially with the functioning or the speed of the retrieval program.

60. The apparatus of claim 59 wherein the loading program loads the geographic

5   boundary classification contents of the first database into the second database in a

more-compact form to save memory space.

61. The apparatus of claim 44, wherein an acceptable caller waiting time during a

wireless telephone call must be less than five seconds.

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62. A method of determining, within an acceptable time of setup of a wireless

telephone call, a classification of a geographic point using said point's geographic

latitude and longitude, comprising the steps of:

accepting from a requesting entity a latitude and longitude for the geographic

15   point;

converting the latitude and longitude to coordinates in a specific coordinate

system uniquely identifying the point;

determining one or more minimum enclosing areas in the coordinate system

for the point;

20   determining the specific classification of the geographic point within the

minimum enclosing area;

returning to the requesting entity the specific classification of the geographic

point.

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63. The method of claim 62 wherein the step of determining one or more minimum enclosing areas for the point further comprises the step of determining one or more minimum enclosing rectangles for the point.

64. The method of claim 63 wherein the step of determining one or more minimum enclosing rectangles for the point further comprises the steps of:

accessing a classification database having a spatial index;

finding in the spatial index a first rectangle that encloses the point;

finding in the spatial index each subordinate rectangle within the first rectangle;

repeating the previous two steps using each subordinate rectangle as a first rectangle until no more subordinate rectangles that enclose the point are found;

returning as minimum enclosing rectangles the set of all subordinate rectangles found in the final step to enclose the point;

for each subordinate rectangle found that encloses the point, returning from the classification database the classification that corresponds to the subordinate rectangle found;

for each classification, returning the set of polygon coordinates defining that classification.

65. The method of claim 62 wherein the step of determining the specific classification of the geographic point within the minimum enclosing area further comprises the steps of:

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for each subordinate rectangle found that encloses the point, retrieving from

the classification database the classification that corresponds to the subordinate

rectangle found;

for each classification, retrieving the set of polygon coordinates defining that

5   classification;

for each set of polygon coordinates, determining whether the point is inside or

outside the polygon;

returning the set of all classifications for which the point is inside the

corresponding polygon.

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66. The method of claim 62 wherein an acceptable time of setup of a wireless

telephone call must be less than one second.

67. The method of claim 62 further comprising the steps of:

    updating components of a form of the classification database and spatial index

15 which is not accessible by a client retrieval process;

    converting the updated components into a form capable of access by a client

retrieval process;

    compressing the converted updated components into a form capable of storage

20 in memory of the system used for client retrieval;

    storing the compressed converted updated components in the memory of the

system used for client retrieval, without preventing client retrieval access to

components not updated;

switching client retrievals to access the compressed converted updated

components of the classification database.

68. A method of determining, within an acceptable caller waiting time during a

wireless telephone call, a location identifier of a geographic point using said point's

geographic latitude and longitude, comprising the steps of:

accepting from a requesting entity a latitude and longitude for the geographic

point;

converting the latitude and longitude to coordinates in a specific coordinate

system uniquely identifying the point;

determining a minimum enclosing area in the coordinate system for the point;

determining the location identifier of the minimum enclosing area;

associating the location identifier with the geographic point;

returning to the requesting entity the location identifier of the geographic

point.

69. The method of claim 68 wherein the step of determining a minimum enclosing

area further comprises the step of determining a minimum enclosing rectangle.

70. The method of claim 69 wherein the step of determining one or more minimum

enclosing rectangles for the point further comprises the steps of:

accessing a classification database having a spatial index;

finding in the spatial index a first rectangle that encloses the point;

finding in the spatial index each subordinate rectangle within the first

rectangle;

repeating the previous two steps using each subordinate rectangle as a first

rectangle until no more subordinate rectangles that enclose the point are found;

returning as minimum enclosing rectangles the set of all subordinate rectangles

found in the final step to enclose the point;

for each subordinate rectangle found that encloses the point, returning from the

classification database the classification that corresponds to the subordinate rectangle

found;

for each classification, returning the set of polygon coordinates defining that

classification.

71. The method of claim 68 wherein the step of determining the specific location

identifier of the geographic point within the minimum enclosing area further

comprises the steps of:

for each set of polygon coordinates, determining whether the point is inside or

outside the polygon;

returning the set of all classifications for which the point is inside the

corresponding polygon.

72. The method of claim 68 wherein an acceptable caller waiting time during a

wireless telephone call must be less than five seconds.

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73. The method of claim 68 further comprising the steps of:

updating components of a form of the classification database and spatial index

which is not accessible by a client retrieval process;

converting the updated components into a form capable of access by a client

5   retrieval process;

compressing the converted updated components into a form capable of storage

in memory of the system used for client retrieval;

storing the compressed converted updated components in the memory of the

system used for client retrieval, without preventing client retrieval access to

10   components not updated;

switching client retrievals to access the compressed converted updated

components of the classification database.

74. A method of increasing the size of a combined geographic classification database

15   and spatial index storable in the memory of a computer system, without altering

substantially the physical structure, logical structure, software content or software

operation within the system, comprising the steps of:

creating a combined geographic classification database and spatial index

stored in a database in the mass storage of a computer system;

20   converting the combined geographic classification database and spatial index

into a form capable of access by a client retrieval process;

compressing the converted geographic classification database and spatial index

into a form capable of storage in the memory of a computer system;

storing the compressed geographic classification database and spatial index in the memory of a computer system.

75. A method of increasing the size of a combined geographic classification database and spatial index storable in the memory of a computer system, without altering substantially the physical structure, logical structure, software content or software operation within the system, comprising the steps of:

creating a combined geographic classification database and spatial index stored in a database in the mass storage of a computer system;

dividing the combined geographic classification database and spatial index into components independently retrievable;

converting each divided geographic classification database and spatial index into a form capable of access by a client retrieval process;

compressing each converted geographic classification database and spatial index into a form capable of storage in the memory of a computer system;

storing each compressed geographic classification database and spatial index in the memory of a computer system.

76. A location management platform apparatus for determining, within an acceptable time of setup of a wireless telephone call, a classification of a geographic point using said point's geographic latitude and longitude, comprising:

means for accepting from a requesting entity a latitude and longitude for the geographic point;

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means for converting the latitude and longitude to coordinates in a specific

coordinate system uniquely identifying the point;

means for determining one or more minimum enclosing areas in the coordinate

system for the point;

5   means for determining the specific classification of the geographic point

within the minimum enclosing area;

means for returning to the requesting entity the specific classification of the

geographic point.

10   77. The location management platform apparatus of claim 76 wherein the means for

determining one or more minimum enclosing areas for the point further comprises

means for determining one or more minimum enclosing rectangles for the point.

78. The location management platform apparatus of claim 77 wherein the means for

determining one or more minimum enclosing rectangles for the point further

comprises:

means for accessing a classification database having a spatial index;

means for finding in the spatial index a first rectangle that encloses the point;

means for finding in the spatial index each subordinate rectangle within the

20   first rectangle;

means for repeating the previous two steps using each subordinate rectangle as

a first rectangle until no more subordinate rectangles that enclose the point are found;

means for returning as minimum enclosing rectangles the set of all subordinate

rectangles found in the final step to enclose the point;

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for each subordinate rectangle found that encloses the point, means for

returning from the classification database the classification that corresponds to the

subordinate rectangle found;

for each classification, means for returning the set of polygon coordinates

5   defining that classification.

79. The location management platform apparatus of claim 76 wherein the means for

determining the specific classification of the geographic point within the minimum

enclosing area further comprises:

for each subordinate rectangle found that encloses the point, means for

10   retrieving from the classification database the classification that corresponds to the

subordinate rectangle found;

for each classification, means for retrieving the set of polygon coordinates

defining that classification;

for each set of polygon coordinates, means for determining whether the point

15   is inside or outside the polygon;

means for returning the set of all classifications for which the point is inside

the corresponding polygon.

20   80. A location management platform apparatus for determining, within an acceptable

caller waiting time during a wireless telephone call, a location identifier of a

geographic point using said point's geographic latitude and longitude, comprising:

means for accepting from a requesting entity a latitude and longitude for the

geographic point;

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means for converting the latitude and longitude to coordinates in a specific

coordinate system uniquely identifying the point;

means for determining a minimum enclosing area in the coordinate system for

the point;

5   means for determining the location identifier of the minimum enclosing area;

means for associating the location identifier with the geographic point;

means for returning to the requesting entity the location identifier of the

geographic point.

10   81. The location management platform apparatus of claim 80 wherein the means for

determining a minimum enclosing area further comprises means for determining a

minimum enclosing rectangle.

82.   The location management platform apparatus of claim 81 wherein the means for

determining one or more minimum enclosing rectangles for the point further

15   comprises:

means for accessing a classification database having a spatial index;

means for finding in the spatial index a first rectangle that encloses the point;

means for finding in the spatial index each subordinate rectangle within the

20   first rectangle;

means for repeating the previous two steps using each subordinate rectangle as

a first rectangle until no more subordinate rectangles that enclose the point are found;

means for returning as minimum enclosing rectangles the set of all subordinate

rectangles found in the final step to enclose the point;

for each subordinate rectangle found that encloses the point, means for

returning from the classification database the classification that corresponds to the

subordinate rectangle found;

for each classification, means for returning the set of polygon coordinates

defining that classification.

83. The location management platform apparatus of claim 80 wherein the means for

determining the specific location identifier of the geographic point within the

minimum enclosing area further comprises:

for each set of polygon coordinates, means for determining whether the point

is inside or outside the polygon;

means for returning the set of all classifications for which the point is inside

the corresponding polygon.

84. A software program stored on machine-readable media for operating a location

management platform to perform the following operations:

accept the coordinates of a geographic point from an input source;

access a classification database having a spatial index;

find in the spatial index a first rectangle that encloses the point;

find in the spatial index each subordinate rectangle within the first rectangle;

repeat the previous two steps using each subordinate rectangle as a first

rectangle until no more subordinate rectangles that enclose the point are found;

return as minimum enclosing rectangles the set of all subordinate rectangles

found in the final step to enclose the point;

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for each subordinate rectangle found that encloses the point, determine from the classification database the classification that corresponds to the subordinate rectangle found;

for each classification, determine the set of polygon coordinates defining that classification

associate the point with each classification and said classification's set of polygon coordinates.